4.7.2 Impurity Concentrations in Incoming Recycled Uranium

No analytical data were found on recycled uranium received at SRS, therefore constituent data for recycle uranium receipts was taken from the data provided in various shipping site draft reports (i.e., Fernald, K-25, and Paducah).

5.0 Mass Flow Activities

5.1 Annual Mass Flows of Recycled Uranium

Annual mass flows of recycle uranium have been completed. Mass flows have been reconciled with shipper/receiver data from other sites in the DOE Complex. Attachments A thru E of this report provides the detailed flow information.

5.2 Mass Flows of Plutonium in Recycled Uranium

Mass flows of plutonium in recycle uranium are shown in Tables 2 thru 5 below. No effort has been made to reconcile these flows with shipping/receiving sites. Values provided for mass of plutonium shipped from SRS are based on analytical data or second order data (i.e., values reported in monthly Works Technical Reports) that was available at SRS. Values for plutonium received at SRS were derived from reported concentrations of materials shipped to SRS in draft site report from Fernald. [21]

5.3 Mass Flow of Neptunium in Recycled Uranium

Mass flows of neptunium in recycle uranium are shown in Tables 2 thru 5 below. No effort has been made to reconcile these flows with shipping/receiving sites. Values provided for mass of neptunium shipped from SRS are based on limited analytical data that was available at SRS. Values for neptunium received at SRS were derived from reported concentrations of materials shipped to SRS in draft site report from Fernald. [21]

5.4 Mass Flows of Technetium in Recycled Uranium

Mass flows of technetium in recycle uranium are shown in Tables 2 thru 5 below. No effort has been made to reconcile these flows with shipping/receiving sites. Values provided for technetium shipped from SRS are based on the assumption that concentrations of technetium in recycle uranium were similar to those provided in DPST-84-385. Values for technetium received at SRS were derived from reported concentrations of materials shipped to SRS in draft site report from Fernald. [21]

The tables below presents the data for recycle uranium shipped/received, disposed of as waste, and held in inventory at SRS by shipping/receiving site, material form, quantity of recycle uranium in metric tons, quantity of Pu, Np, and Tc in units of grams.

Table 2 - SRS Shipments of Recycle Uranium

Receiving Site	Material Form	Quantity Shipped (MTU)	Quantity of Pu (grams)	Quantity of Np (grams)	Quantity of Tc (grams)
Y-12 Plant	UNH	91	.023	6.67	7,462
Fernald	UNH	74	.019	5.43	6,068
Y-12 Plant	Oxide	45	.056	5.41	48.6
Fernald	Oxide	2,382	2.95	412.8	2570
Paducah	Oxide	9,257	12.63	1812	9,998
K-25 Plant	Oxide	10,290	19.32	2469.6	11,113
Fernald	Scrap	6580	7.66	1310.77	9968.14
*Y-12 Plant	Scrap	19.3	---	---	---

*No information is available for Y-12 Metal at this time.

Table 3 – SRS Receipts of Recycle Uranium

Shipping Site	Material Form	Quantity Received (MTU)	Quantity of Pu (grams)	Quantity of Np (grams)	Quantity of Tc (grams)
Fernald	Metal	45,342	35.85	6,158.80	46687.29
Fernald	Oxide	864	1.51	258.34	1969.06
*Y-12 Plant	Metal	180.8	---	---	---
Y-12	Oxide	4.2	.007	0.58	4.54
Paducah	Oxide	5	.007	1.2	5.4
K-25 Plant	Oxide	14	.024	3.36	15.12

*No information is available for Y-12 Metal at this time.

Table 4 – Recycle Uranium Waste at SRS

Waste Type	Quantity (MTU)	Quantity Pu (grams)	Quantity Np (grams)	Quantity Tc (grams)
Solid post 1964	239.7	.042	7.46	54.56
Liquid post '64	287.5	.052	9.27	67.99
All Forms 60-63	28.7	.005	.93	6.79
*Waste pre-'60	86.9	.016	2.80	20.55

No data was available for recycle uranium disposed of as waste prior to 1960. The value indicated was derived assuming that the percentage of material going to waste prior to 1960 and after 1960 was similar. Constituent concentrations were assumed to be similar to that found in material received at the site from Fernald for depleted, normal and enriched uranium, as provided in the Fernald Site Draft Report, Table F-3-1.

Table 5 - SRS Inventory On-Hand

Material Type	Quantity (MTU)	*Quantity Pu (grams)	*Quantity Np (grams)	*Quantity Tc (grams)
Normal Uranium	36	.063	10.76	82.04
Depleted Uranium	22,289	.156	56.84	203.28
Enriched Uranium	156	.273	46.64	355.52

* Quantities of constituents were derived by assuming constituent concentrations similar to that found in material received at the site from Fernald for depleted, normal and enriched uranium, as provided in the Fernald Site Draft Report, Table F-3-1.

5.5 Worker Exposure to Plutonium, Neptunium, and Technetium from Recycled Uranium

As indicated in the discussion in Section 2.3 of this report, SRS workers were not routinely monitored for exposure to plutonium, neptunium, or technetium that might have been present in the recycle uranium streams, as these radioisotopes contributed less than 10% of the total dose received by uranium workers [15]. However, the activities in F-Area A-Line and Fuel/Target Fabrication Facilities have been identified as having the greatest potential to expose workers to radioactive constituents of interest in the recycle uranium stream. The areas and activities are described in detail below. While these activities may not include every possible exposure pathway, they do represent those activities and actions that the Site Team, Working Group Team, and Headquarters Team believe presents the highest probability for worker exposure.

Casting Charge Preparation

Charge Preparation was one of the areas in fuel manufacturing activities having a high potential for uranium assimilation, as it was an activity where the recycled enriched uranium metal and unclad intermediate U-Al products were processed. This activity included the receipt, de-packaging, storing, and weighing out of quantities of uranium metal for the casting operation. As indicated in Table 1, Section 2.4, the recycled uranium metal handled by workers could have contained 1.75 ppb Pu, 299 ppb Np, and 2279 ppb Tc. The activity was conducted in a ventilated enclosure with HEPA filtered exhaust, engineered to minimize the contamination/assimilation potential. Two personnel were required to perform this activity, which consumed the major portion of an eight-hour shift. The facility operated with as many as three shifts per day. Administrative controls required personnel performing this activity to wear respirators and other protective clothing. If workers failed to wear the proper personal protective equipment then there would have been an increased risk of exposure to transuranic and fission products in the recycle uranium.

Casting

Another activity in the fuel manufacturing process having a high potential for uranium assimilation, as it was an activity where the recycled enriched uranium metal and unclad intermediate U-Al products were processed was casting. This activity involved melting and alloying quantities of uranium metal, U-Al scrap, and aluminum. The level of constituents of interest in the material handled in this activity was the same as that in Charge Preparation. In this operation the material was changed from a solid to a liquid, with some vapors present in the casting furnace and enclosure. Loading and unloading of the furnace subjected personnel to potential exposure. Casting was a labor-intensive operation, which consumed the major portion of an eight-shift for four to five personnel, up to three-shifts per day. Administrative controls required personnel performing this activity to wear respirators and other protective clothing. If workers failed to wear the proper personal protective equipment then there would have been an increased risk of exposure to transuranic and fission products in the recycle uranium.

U-Al Alloy Machining

The U-Al melt from the furnace was cast to form hollow cylindrical ingots. These ingots were machined into cores and assembled with aluminum end plugs, inner and outer sheaths and an evacuation tube to make a composite pre-extrusion billet. The level of constituents of interest in the material handled in this activity was the same as that in Charge Preparation. The pre-extrusion billet was out-gassed and extruded to form a pre-extrusion log, which was machined into co-extrusion cores. The machining operation had a high potential for producing airborne activity, therefore during the machining operation personnel at the lathe were required to be in respirators and other personal protective equipment. This activity consumed the major portion of an eight-hour shift for two to four personnel, up to three shifts per day. If workers failed to wear the proper personal protective equipment then there would have been an increased risk of exposure to transuranic and fission products in the recycle uranium.

HEPA Filter Change-Out

Ventilation from enclosures and areas of contamination, within Building 321-M, exited the facility through HEPA filters located on the roof. These filters were replaced six to eight times per year. This periodic operation involved two personnel who physically removed/replaced the filters and a radiation control inspector who monitored for airborne radioactivity. Constituents of interest concentrations are assumed to be similar to those present in the uranium received on-site, as no analysis was available for materials on the HEPA filters. Personnel performing the activity were required to wear respirators and other protective clothing. If workers failed to wear the proper personal protective equipment then there would have been an increased risk of exposure to transuranic and fission products in the recycle uranium.

F Area, A-Line Facility Clean-Up

In the Uranium Oxide Conversion Facility (FA-Line) the potential existed for workers to come into physical contact with recycle uranium. In this facility, liquid uranyl nitrate solution from F-Canyon was concentrated and thermally de-nitrated to an oxide powder (UO_3). Facility clean-up involved removing UO3 dust from floors and equipment each shift. Personnel performing this activity, usually four to five people for one hour per shift, up to three shifts per day, were required to wear respiratory equipment and other protective clothing. If workers failed to wear the proper personal protective equipment then there would have been an increased risk of exposure to transuranic and fission products in the recycle uranium.

Removal of UO3 from Denitrator

In the A-Line Facility, liquid uranyl nitrate solution from F-Canyon was concentrated and thermally de-nitrated to an oxide powder (UO_3). This powder was vacuumed (gulped) from the denitrator pots by hand, collected on filters, then transferred to a drum loading facility for storage in 55-gallon drums. The nature of the oxide conversion operations, necessitated that workers handle uranium oxide dust, and work in areas where uranium oxide dust was present. This activity consumed the major portion of an eight-hour shift for four to five personnel, up to three shifts per day. Administrative controls required personnel performing this activity to wear respirators and other protective clothing. If workers failed to wear the proper personal protective equipment then there would have been an increased risk of exposure to transuranic and fission products in the recycle uranium.

5.6 Environmental contamination from Plutonium, Neptunium, and Technetium in Recycled Uranium

See Section 2.5 of this report.

6.0 Conclusion

6.1 Conclusions

No evidence was uncovered during the course of this study, which would indicate SRS recycled uranium operations presented a challenge to radiological protection measures historically used at the site. These protection measures notwithstanding, records indicate that 99 workers received internal doses of uranium over the history of the plant, which are well documented in site incident reports and personnel dosimetry files. It is likely that the workers receiving internal uptakes of uranium were also exposed to transuranics present in the uranium at very low levels as discussed in Section 3 of this report. Results of the study indicate that SRS took reasonable care in the conduct of recycle uranium operations to safeguard the health and safety of site workers, and the public, as well as, protecting the environment.

Data supporting this study were gathered from numerous site reports, shipping/receiving records, discussions with site current and former employees, and discussions with receiving/shipping site employees from around the DOE Complex. Data sources are believed to be as accurate as measurement techniques permitted at the time measurements